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Climate of the Past Discussions

Interactive comment on "Northern high-latitude climate change between the mid and late Holocene – Part 1: Proxy data evidence" *by* H. S. Sundqvist et al.

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I would like to comment shortly on one specific issue raised by reviewer 1, namely the possible co-variations of the estimation of climate at 6000 BP and the present climate. This point seems to also confuse the authors of the discussion paper, as reflected in their reply to reviewer 1.

Reviewer 1 has pointed to the possibility that the variability of the estimations of the mean climate at 6000 BP and today may be correlated. This would mean that either

non-climatic variability inherent in the proxies is correlated, or that the internal climate variability itself could be correlated at the regional scales represented by the proxies. I would like to comment on the second possibility, as the first should be addressed by persons with a deeper knowledge of proxy records.

As indicated by the reviewer, I think the question of whether the internal centennial climate variability at centennial timescales may be correlated several thousand years apart is quite difficult to address. All climate records at these time scales , if they are based on good climate proxies, should reflect the variability of the external forcings, so that in my opinion there is not a clear way to disentangle the possible stochastic co-variability from the deterministic effect of the external forcing from the analysis of observational data.

A clearer separation could be provided by the analysis of a long control climate simulation over several thousand years, a simulation where the external forcing has been kept constant. Another approximate way could be the analysis of an externally forced simulation. It can be assumed that the effects of the orbital forcing is constrained to the very low-frequencies, in millennial timescales. By filtering this low frequency component, one could hope that the residual variability is caused only by the internal climate processes. Thus, the autocorrelation function of the residual variations could indicate an order of magnitude of the de-correlation time. If the autocorrelation function decays to zero for time lags clearly less that several millennial, one could reasonably assume that the internal variability is unlikely to be responsible for co-variability at millennial time scales.

Unfortunately, such long simulations with global General Circulation Models are rare, since they require large computer resources. We have completed two simulations covering almost the whole Holocene, starting at 7000 years BP, with the climate models ECHO-G, driven by orbital, greenhouse gases and variations of solar irradiance. The model ECHO-G is a a climate model that was used for the suite of simulations for the Fourth IPCC Report, with a horizontal resolution of about 3.75 degrees. These

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simulations are not yet published, but I will comment shortly on a few results that may be relevant for the present discussion. The evolution of the near-surface temperature in the Fennoscandian region displays a temperature drop between 6000 BP and 1000 BP of about 1 K in summer (June-August) and about 0.5 K in winter (December-February) (Fig 1A). Present temperatures (20th century mean) are about 0.75 K above the mean over the past millennium. The summer temperature drop is very likely linked to the orbital forcing.

The autocorrelation function of the centennial means of Fennoscandian summer temperature, after removing the long-term trends caused by the orbital forcing (Fig 1B), displays a noise structure - the number of samples is not very large - but remains within the band between -0.2 and 0.2 for a lag of up to 30 centuries (Fig 1C). This shape of this function is compatible with an autoregressive process of order one (for centennial temperature means) according to Monte Carlo simulations (Fig 1C). This would indicate that it is unlikely that there exists a co-variability of the clime variability at 6000 BP and in the present climate in this simulation.

A thought about the possible processes that could be responsible for this co-variability is not straight forward either. The thermohaline circulation could perhaps cause autcorrelations in the timescales of a few centuries.

Interactive comment on Clim. Past Discuss., 5, 1819, 2009.

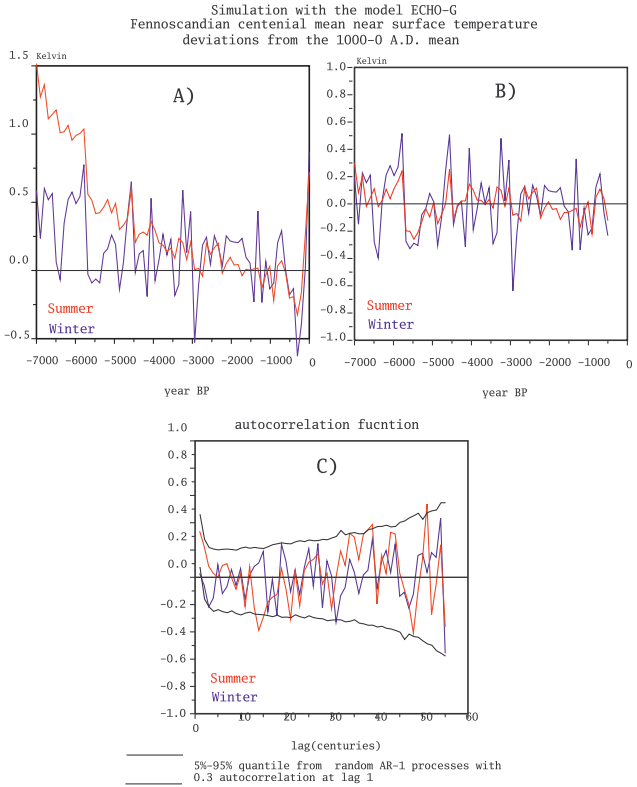

Fig. 1. Simulated Fennoscandian surface temperature A) anomalies from the 1000-0 A.D. mean; B) after removal of the millennial variations; C) autocorrelation of the residuals

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